An Interpretation of the Relationships Among the Species of *Parapercis,* Family Mugiloididae

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This work is based on data taken from the descriptive study by Cantwell (1964) of the genus *Parapercis,* fishes of the Indo-Pacific oceans. The descriptions were based on anatomical studies, and each structure was analyzed to determine its variation within a species and its value in identification.

Here an effort is made to employ those characters showing the least variation within species to establish possible affinities between species, to define species groups, and to determine relationships among them.

METHODS

Using the method described by Cain and Harrison (1958), seven characters were utilized to determine the affinity of the members of this genus. The characters used were the number of teeth in the outer row of the lower jaw, dorsal spines, dorsal rays, total anal rays, caudal vertebrae, the shape of the spinous dorsal, and the connection between the spinous and soft dorsal. The latter two characters, not being measurements or meristic data, were assigned numerical values: 5 was given if the dorsal spines became progressively longer posteriorly; 4 if the middle spines were longest; 3 if the membranes were attached to the first soft dorsal ray opposite the tip of the last spine; and 2 if a connection occurred at the base of the first soft dorsal ray.

Briefly, this method obtains a combined value for the differences between two forms. An example of this method is given (Tables 1 and 2), using only 5 of the 26 species. First, the means of the measurements of the same characters in all the forms were obtained. Next, all the mean values for each character were divided by the maximum mean value for that character; this gives the reduced values and removes the bias produced by the different units of measurement (Table 1). Third, all the forms are compared with each other, two at a time, by obtaining the differences between the reduced vaues of each character (Table 2). Low values imply close affinity, higher values more distant relationship.

When the species are compared with each other, two at a time (Table 2), the total differences fall into two categories. Species A, B, and C are very much alike, and are different from D and E, which resemble each other closely.

RESULTS

Comparisons of all 26 species of the genus, using this method, show the presence of six groups of species with great affinity toward each other. The mean differences of reduced values within these groups are: I, 18.8; II, 10.0; III, 3.2; IV, 21.7; V, 0.0; and VI, 6.4. In every instance each member of a group has a greater affinity for the other members of its own group than for any member of any other group. These groups are listed below.

Group I: *binivirgata, multifasciata, mimaseana, sexfasciata, muronis, aurantiaca.*

Group II: *cylindrica, haackei, ommatura, pulchella, snyderi.*

Group III: *emeryana, filamentosa, nebulosa, schauinslandi, alboguttata.*

Group IV: *cephalopunctata, tetracantha, xanthozona, hexophthalma, clathrata, polyophthalma.*

Group V: *ramsayi.*

Group VI: *colias, gilliesi, allporti.*

The mean differences of reduced values between groups give the degree of relationship among groups, as shown in Table 3.

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TABLE 1

Reduced Values of Seven Characters for Five Species of the Genus *Parapercis*

CHARACTER	SPECIES				
	A	B	C	D	E
Caudal vertebrae	99.6	99.3	100.0	90.1	90.3
Dorsal spines	98.8	97.4	98.4	98.8	98.8
Dorsal rays	94.5	94.7	95.2	90.4	86.5
Anal rays	99.0	99.4	100.0	94.1	89.3
Teeth in outer row of lower jaw	80.0	60.0	80.0	60.0	60.0
Shape of spinous dorsal	100.0	100.0	100.0	80.0	80.0
Connection from spinous dorsal	100.0	100.0	100.0	67.0	67.0

TABLE 2

Differences Between the Reduced Values: Forms Compared with Each Other, Two at a Time

CHARACTER	SPECIES									
	A–B	A–C	A–D	A–E	B–C	B–D	B–E	C–D	C–E	D–E
Caudal vertebrae	0.3	0.4	9.5	9.3	0.7	9.2	9.0	9.9	9.7	0.2
Dorsal spines	1.4	0.4	0.0	0.0	1.0	1.4	1.4	0.4	0.4	0.0
Dorsal rays	0.2	0.7	4.1	8.0	0.5	4.3	8.2	4.8	8.7	3.9
Total anal rays	0.4	1.0	4.9	9.7	0.6	5.3	10.1	5.9	10.7	4.8
Teeth in outer row of lower jaw	20.0	0.0	20.0	20.0	20.0	0.0	0.0	20.0	20.0	0.0
Shape of spinous dorsal	0.0	0.0	20.0	20.0	0.0	20.0	20.0	20.0	20.0	0.0
Connection from spinous dorsal	0.0	0.0	33.0	33.0	0.0	33.0	33.0	33.0	33.0	0.0
Total	22.3	2.5	91.5	100.0	22.8	73.2	81.7	94.0	102.5	8.9

The analysis of these data indicate that Group VI, those species found only near the southeastern tip of Australia, Tasmania, and New Zealand, are more closely related to those species found in Japanese waters (Group I), than to those groups in the central west Pacific and the Indian oceans. *P. ramsayi,* the only species in Group V and from southeastern Australia, is also more closely related to those forms from Japan than to those from the central west Pacific area. The only species endemic to the Hawaiian Islands, *P. schauinslandi,* was found to have a greater affinity for those species of the central west Pacific and Indian oceans than for those found primarily in Japanese waters or in southeastern Australia and New Zealand.

This close relationship between those species of Japanese and southeastern Australian waters supports the phenomenon of bipolarity. Bipolarity, or amphipolarity, is defined by Ekman (1953: Chap. 11) as bipolar taxonomic development which presupposes a center of distribution in the tropics, which served as an intermediary link between amphipolar species. Sverdrup et al. (1942:849) refer to this phenomenon as bipolarity of relationship, and define it as "a bipolar distribution in which animals of higher latitudes are more closely related taxonomically to each other than to those of lower latitudes."

Another phenomenon of parallel development exhibited by the species of the genus *Parapercis* is the larger size of the colder water forms. The mean greatest body depths of all species from Australian, Indo-central Pacific, and Japanese waters are, respectively, 195.2, 163.2, and 184.9, with mean least body depths, respectively, of 95.4, 87.8, and 94.5. The longest individuals are also taken from Australia and Japan.

TABLE 3

MEAN DIFFERENCES OF REDUCED VALUES BETWEEN GROUPS OF SPECIES OF THE GENUS *Parapercis*

GROUP	I	II	III	IV	V
I					
II	81.5				
III	89.2	33.6			
IV	55.9	65.7	51.0		
V	44.7	86.7	96.8	61.4	
VI	48.3	70.7	88.3	51.3	79.1

DISCUSSION

The horizontal distribution of this genus is characteristic of many littoral fishes and other littoral fauna of the tropical and subtropical Indo-Pacific oceans. The great expanse of water in the East Pacific Ocean forms a barrier against dispersal of many of the shore forms to the west coast of America, whereas temperature plays an important role in restricting warm water animals from migration around the southern tip of Africa. Temperature is also the limiting factor in northern and southern latitudes for littoral animals of this large faunal area.

The genus *Parapercis* ranges from southern Japan to the Hawaiian and Tuamotu islands, southwestward to New Zealand and Tasmania, west to Durban on the east coast of Africa, thence north to the Red Sea and across the Indian Ocean.

The Indo-Malayan subregion of the Indo-west Pacific contains 11 of the 26 species of the genus, *filamentosa* being the only one endemic to this area. The number of representatives decreases in a westerly direction, with only 1 species, *nebulosa,* found on the east coast of Africa as far south as Durban. The subregion consisting of the islands of the central Pacific excluding Hawaii has but 5 species, none of which is endemic to this subregion. *P. schauinslandi,* 1 of 2 species found in Hawaii, has not been reported from any other subregion. Of the 10 species of the subtropical Japanese waters, 4 are endemic to this subregion: *mimaseana, muronis, sexfasciata,* and *aurantiaca.* The Solanderian province of northeast Australia contains 5 species, while the Dampierian province in the northwest has 2, none of which is endemic. In the south the Peronian province has 6 representatives, of which *binivirgata, haackei, allporti,* and *ramsayi* are common to no other subregion. *P. colias* and *gilliesi,* the only 2 species of the genus taken from New Zealand waters, are also endemic to this area.

Using the Indo-Malayan subregion as the approximate center of the geographic range of this genus, the above distributional data indicate that the further one moves away from this center, in any direction, the more the addition of endemic species replaces the progressively depleted Indo-Malayan forms. Speciation, as the data indicate, has taken place on the periphery of the range, i.e., in those areas of comparative geographic isolation.

Mayr (1942), Darlington (1948), and Brown (1957 and 1958) agree that geographic isolation plays a major role in the process of evolving distinct species, although there is one great point of difference among the three. Darlington and Brown state that an adaptive change occurs in the center and spreads out to the periphery; then the population recedes, leaving some members isolated. Another change occurs in the center and spreads outward. If this second change is different enough from the previously isolated populations on the periphery, a new species is recognized. Mayr, however, postulates that "a new species develops if a population which has become geographically isolated from its parental species acquires, during the period of isolation, characters which promote or guarantee reproductive isolation when the external barriers break down."

The data presented here, showing the comparatively large numbers of endemic species on the periphery of the range, support these modern views on speciation in that geographic isolation plays a major role in the formation of distinct species. The data, however, do not favor either viewpoint as to where the adaptive changes occur.

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